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16. ABSTRACT

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Abstract

This paper describes part of the Environmental Protection Agency's efforts in collecting data during incineration of various RCRA wastes to determine the quality of the residuals being generated. Ash and effluent streams were sampled and analyzed after rotary kiln incineration of three different wastes at an EPA facility in Jefferson, Arkansas. These wastes were RCRA Waste Code K024 (distillation bottoms from the production of phthalic anhydride), K001-PCP (wastewater treatment sludge from wood preserving processes using pentachlorophenol), and K037 (wastewater treatment sludge from the production of the pesticide disulfoton). Industry practice is to dispose of K024 and K037 in permitted landfills. K001-PCP is usually either incinerated or landfilled. Grab samples were taken at five points in the incineration system: waste feed, kiln ash, scrubber makeup water, scrubber blowdown, and stack gas. The data on waste feed, ash and scrubber water composition (not stack gas) are discussed in the paper. Rotary kiln incineration appears to be an acceptable treatment process for the three RCRA wastes that were tested.

Key Words: Incineration
Rotary kiln
Treatment
Phthalic anhydride
Pentachlorophenol
Disulfoton

Introduction

The USEPA's Hazardous Waste Engineering Research Laboratory (HWERL) has collected data on the incineration of various RCRA wastes to determine the quality of the residuals being generated. Recently, ash and effluent streams were sampled and analyzed after the incineration of three different wastes at an EPA facility in Jefferson, Arkansas. These wastes were 1) distillation bottoms from the production of phthalic anhydride (RCRA waste code K024), 2) wastewater treatment sludge from wood preserving processes using pentachlorophenol (K001-PCP), and 3) wastewater treatment sludge from the production of disulfoton (K037). In order to completely characterize all feed and residual streams, the constituents that were analyzed included an extensive list of volatile and semi-volatile organics and metals. Table 1 lists these constituents. In addition, other compounds that were known or suspected to be in a given stream were also analyzed.

Currently, industry practice is to dispose of K024 and K037 in permitted landfills. K001-PCP is usually either incinerated or landfilled.

K024, K001-PCP, and K037 were chosen for testing because little information on their incinerability is available. Generators of each waste type were identified and contacted, and drums of waste were delivered to the incinerator site for testing.

Description of the Wastes

K024

The K024 waste is distillation bottoms from the production of phthalic anhydride from naphthalene. Estimated generation is a maximum of 500 tons per year from a single source.

During the production process, K024 is poured directly into 55-gallon drums (at 250 deg C) where it cools and solidifies. The head space which is created upon contraction of the cooled material is filled with "flaked" K024. Flaking is achieved by slowly pouring the hot K024 stream onto a water-cooled stainless steel conveyor belt and using hand-held hammers to break the solidified K024 into small pieces.

The waste incinerated in this test was the flaked K024.

Major constituents in the sampled K024 include the following (approximate percentages):

Phthalic Anhydride	5%
Ash	10%
Water	<1%
Other Constituents	<1%
Polymeric materials	83%

The polymeric materials are reported by the generator to be produced from reactions of sodium carbonate, 1,4-naphthaquinone, and other organic and inorganic impurities from process feed materials. A significant parameter influencing the incinerability of K024 includes its heating value, which was determined to be approximately 10,000 BTU/lb.

K001-PCP

K001-PCP is bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use pentachlorophenol (PCP). Wastewaters that are generated during wood preserving operations are discharged to holding ponds which are periodically emptied. These wastewaters contain phenolic compounds, including penta- and tetrachlorophenol, volatile organic solvents such as benzene and toluene, and polynuclear aromatic components of creosote which is also used for wood preserving. Dredging of the K001 bottom sludge for disposal causes mud and other debris to be included with the K001 sludge.

Major constituents in the sampled K001-PCP include the following (approximate percentages):

Soil	40%
Water	30%
Organics	20%
Wood Chips	10%

Significant parameters influencing the incinerability of K001-PCP include:

Ash Content	12 to 51%
Heating Value	3,800 to 8,300 BTU/lb
PCP Content	970 to 3,000 ppm

The wide range of values indicates the variation in composition that can be expected in K001-PCP, even from the same source.

K037

K037 is wastewater treatment sludge from the production of disulfoton (a pesticide). Disulfoton unit process water is sent to a solvent recovery unit where disulfoton is recovered and recycled. Filtration of the wastewater from solvent recovery results in K037 sludge. Estimated generation is 20 to 30 tons per year.

Major constituents in the sampled K037 include the following (approximate percentages):

Disulfoton	20%
Ash	75
Toluene	0.2
Water	Balance

The heating value of K037 is approximately 3,500 BTU/lb.

Safety Considerations

The pilot plant is located on the grounds of the National Center for Toxicological Research (NCTR). Access to the site is limited by a guarded main gate.

An important consideration was the protection of workers handling the hazardous wastes and taking samples. Level B protective equipment was worn when handling some of the waste where the potential for significant exposure existed. When sampling scrubber effluent, full-face splash shields and viton gloves were worn.

Description of the CRF

Engineering judgment based on waste characteristics such as heat content, ash content, and organic components in the waste, indicated rotary kiln incineration as the applicable treatment for the three hazardous waste codes identified.

The EPA owns and operates a RCRA-permitted pilot-scale rotary kiln incinerator in Jefferson, Arkansas, for its research efforts. This kiln, which is part of the EPA's Combustion Research Facility (CRF), is rated at approximately 2.5 million BTU/hr and 1-hour solids retention time at 0.5 rpm.

A criterion established by EPA for this test program was that the selected incinerator must represent the performance achievable by a well-designed and well-operated system. The CRF rotary kiln is such a system. Also, testing at the CRF allowed EPA to obtain desired stack test data and treat a smaller quantity of waste material at a lower cost than at a commercial incinerator.

Rotary Kiln and Scrubber Systems

Table 2 presents the design characteristics of the CRF's rotary kiln system. Figure 1 shows the system's general configuration.

A ram feeder was used to inject 1.5-gallon cylindrical fiber packs containing the feed material into the kiln chamber. The kiln's design temperature is 1,000 deg C (1832 deg F). The feed rate was controlled by the ram feed operator and was occasionally adjusted as temperature and carbon monoxide (CO) levels were monitored.

The hot combustion gases from the kiln pass through an afterburner for further incineration. The afterburner design temperature is 1200 deg C (2200 deg F) with an approximate 2-second residence time. Both the kiln and afterburner use propane for start up fuel, and as supplementary fuel when required, during a waste burn.

The gases leaving the afterburner enter a venturi scrubber, followed by a packed tower, a carbon bed, and a high-efficiency particulate air (HEPA) filter in series (Figure 1). The carbon and HEPA filter are required by Arkansas since the CRF is an experimental facility and may not always be operated at optimum conditions.

Sodium hydroxide is added to the scrubbing system (venturi and packed tower) to maintain a pH greater than 7. Makeup water is added at a rate of 5 to 10 gallons per minute, and the water system is blown down continuously at a rate of 2.0 to 2.5 gallons per minute.

Operating Conditions

Strip charts continuously monitor and record oxygen, carbon monoxide, and carbon dioxide at the afterburner outlet and after the scrubber system. Operators also manually record these parameters along with temperatures after the kiln, afterburner, and scrubber system, pressure drop across the scrubber system, feed rate, and makeup and blowdown water flow every 15 minutes. A computer records other operating parameters (propane flow, combustion air, temperature) every 20 seconds.

Waste feed rates are shown in Table 3. These were calculated based on heat content and maximum design temperatures (see Table 2). Temperature in the kiln was controlled by increasing or decreasing the waste fed by the ram feeder, and by the amount of combustion air and propane introduced.

Exact determination of solids retention time was difficult to establish. Manufacturer design information indicates a retention time of 60 minutes for 0.5 rpm kiln rotation speed. In a previous test using an adsorbent clay to simulate soil a retention time of 60 minutes for 0.2 rpm kiln rotation speed was determined.

Sample Points

All samples were collected as grab samples. Figure 2 presents the sampling and monitoring points of the CRF rotary kiln system. The following four streams were sampled:

Waste Feed
Rotary Kiln Ash
Scrubber Makeup Water
Scrubber Blowdown

The samples of waste feed were scooped from each of the drums during the loading of the fiber packs. One representative sample was collected from each drum.

Ash samples were collected from the ash collection drum (located at the exit of the kiln chamber) which was allowed to cool overnight. The ash drum was replaced as required.

Calculation of material balances around the incinerator was not attempted.

Scrubber makeup water was collected directly from the inlet to the scrubber system. The water comes from the site's drinking water supply. Scrubber water blowdown samples were taken from the recycle tank blowdown line prior to entry into the holding tanks. The system was drained into a holding tank each day after testing and refilled with fresh water the next test day.

Incinerator Performance

During each test the incinerator operated continuously. Propane was fired overnight to maintain the system at temperatures similar to those of the test burns.

During the tests, kiln temperatures varied due to batch-charging of high heat-content wastes. Table 3 shows the temperatures that were measured for the three tests. The temperature fluctuation at the kiln exit followed the charge cycle.

Discussion of Results

K024

Volatiles

The only volatile organic compound detected in the scrubber influent was ethyl acetate (18 ug/L). Some scrubber effluent samples contained low levels of halogenated compounds as well as MEK, acetone, and ethyl acetate. Feed and ash samples did not contain any of the listed volatile compounds, except for MEK. MEK levels reached 1100 ug/g in the ash and 690 ug/g in the feed. The MEK concentrations were very similar to the 770 ug/g detected in the methanol blank, indicating MEK was a laboratory contaminant in the ash and feed analyses.

Semivolatiles

No Table 1 compounds were detected in the scrubber influent or effluent, feed or ash samples. Other constituents found in the feed include phthalic anhydride (2,600-29,000 ug/g) and anthracene dione (5,400-6,700 ug/g). These two constituents were not detected in ash and scrubber samples.

Metals

Scrubber effluent samples revealed levels of arsenic, barium, cadmium, chromium, copper, nickel, lead, and zinc in the range of .03-10 ug/L. Metals analysis on ash samples determined high levels of barium (3,900 ug/g), lead (100 ug/g), and zinc (170 ug/g). Also detected but at much lower levels were arsenic, chromium, copper, and vanadium. Toxicity Characteristic Leaching Procedure (TCLP) analyses indicated the presence of barium (.38), chromium (.37), nickel (1.5), lead (2.3), and zinc (1.6 ug/g). Metals analysis of the feed was not determined.

K001-PCP

Volatiles

Methanol extracts of feed and ash samples contained 10 to 110 ug/g of various substituted benzenes (toluene, ethylbenzene, xylene, and styrene). No detectable volatile constituents were found in the scrubber effluent samples.

Semivolatiles

No PCP or other semivolatile constituents were detected in any of the scrubber water or ash samples. Feed samples contained fairly high levels of twelve polynuclear aromatic hydrocarbons (e.g., anthracene, fluoranthene, and naphthalene) ranging up to 50,000 ug/g. Other

analytes detected include substituted phenols in concentrations up to 2,300 ug/g. PCP concentrations in the feed ranged from 920 to 3,000 ug/g.

Metals

Scrubber influent analyses indicated the presence of barium (.12 ug/ml), copper (.15 ug/ml), lead (.021 ug/ml), and zinc (1.1 ug/ml). These same metals appeared in effluent samples at approximately the same levels, except for lead (.2 ug/ml) and including arsenic (.16 ug/ml). Feed samples contained levels of arsenic (2.9 ug/g), barium (30 ug/g), copper (11 ug/g), lead (11 ug/g), and zinc (64 ug/g) while ash samples contained barium, lead, and zinc at reduced levels. TCLP analyses indicated low levels (<0.3 ug/ml) of barium, lead and zinc in the ash.

K037

Volatiles

Feed sample extracts contained levels of toluene ranging from 200 to 2,000 ug/g. No volatile constituents were detected in the scrubber water samples. Methanol extracts of ash samples contained levels of MEK ranging from 140 to 640 ug/g.

Semivolatiles

No detectable semivolatile constituents were found in the scrubber water, ash, or feed samples.

Metals

Feed samples contained arsenic, barium, cadmium, chromium, copper, nickel, lead, vanadium, and zinc. Metals detected in the scrubber effluent included copper (4.7), lead (11), zinc (16), arsenic (.3) and cadmium (.06 mg/L). Ash samples contained all nine metals (from 5 to 940 mg/Kg). TCLP extracts of ash contained barium, chromium, copper, nickel, lead, vanadium and zinc at detectable levels (.02 to 10 mg/L).

Pesticides/Herbicides

Analysis of organophosphorous pesticides indicated a high level of disulfoton in the feed (104,000-246,000 ug/g). In the ash samples, disulfoton was less than 0.007 ug/g. No other organophosphorous or organochloride pesticides were detected in any samples. None of the four chlorinated herbicides (2,4-D, Silvex, 2,4-D, and Dinoseb) were detected.

Conclusions

Extensive data on waste feed, ash and scrubber water composition as well as TCLP data on ash samples were developed and evaluated in the course of testing the phthalic anydride (K024), pentachlorophenol (K001-PCP) and disulfoton (K037) process wastes at the CRF. Rotary kiln incineration appears to be an acceptable treatment process for the three RCRA wastes. In all tests, no significant levels of volatiles or semi-volatiles were found in ash and scrubber water effluents indicating that rotary kiln incineration effectively destroys or removes these compounds. Metals in feed streams partitioned between the residue streams with the majority appearing in the ash.

References

1. EPA, Onsite Engineering Report of Treatment Technology Performance and Operation: Incineration of K024 Waste at the USEPA Combustion Research Facility, Cincinnati, OH, November 1987.

2. EPA, Onsite Engineering Report of Treatment Technology Performance and Operation: Incineration of K001 Pentachlorophenol (PCP) Waste at the USEPA Combustion Research Facility, Cincinnati, OH, November 1987.

3. EPA, Onsite Engineering Report of Treatment Technology Performance and Operation for Incineration of K037 Waste at the Combustion Research Facility, Cincinnati, OH, November 1987.

4. EPA, Pilot-Scale Incineration Tests of Stillbottoms from Phthalic Anhydride Production (K024)," Cincinnati, OH, November 1987.

Table 1. Constituents Analyzed

Parameter	CAS no.
VOLATILES	
Acetonitrile	75-05-8
Acrolein	107-02-8
Acrylonitrile	107-13-1
Benzene	71-43-2
Bromodichloromethane	75-27-4
Bromomethane	74-83-7
Carbon tetrachloride	56-23-5
Carbon disulfide	75-15-0
Chlorobenzene	108-90-7
2-Chloro-1,3-butadiene	126-99-8
Chlorodibromomethane	124-48-1
Chloroethane	75-00-3
2-chloroethyl vinyl ether	110-75-8
Chloroform	67-66-3
Chloromethane	74-87-3
3-Chloropropene	107-05-1
1,2-Dibromo-3-chloropropane	96-12-8
1,2-Dibromoethane	106-93-4
Dibromomethane	74-95-3
Trans-1,4-Dichloro-2-butene	110-57-6
Dichlorodifluoromethane	75-71-8
1,1-Dichloroethane	75-36-3
1,2-Dichloroethane	107-06-2
1,1-Dichloroethylene	75-35-4
Trans-1,2-Dichloroethene	156-60-5
1,2-dichloropropane	78-87-5
Trans-1,3-Dichloropropene	10061-02-6
Cis-1,3-Dichloropropene	10061-01-5
1,4-Dioxane	123-91-1
Ethyl cyanide	10712-0
Ethyl methacrylate	97-63-2
Iodomethane	74-88-4
Isobutyl alcohol	78-83-1
Methyl ethyl ketone	78-93-3
Methyl methacrylate	80-62-6
Methyl methanesulfonate	66-27-3
Methylacrylonitrile	126-98-7
Methylene chloride	75-09-2
Pyridine	110-86-1
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethene	127-18-4
Toluene	108-88-3
Tribromomethane	75-25-2
1,1,1-Trichloroethane	71-55-6
1,1,2-Trichloroethane	79-00-5
Trichloroethene	79-01-6
Trichloromonofluoromethane	75-69-4
1,2,3-Trichloropropane	96-18-4
Vinyl chloride	75-01-4

Parameter	CAS no.
SEMIVOLATILES	
Acenaphthalene	208-96-8
Acenaphthene	83-32-9
Acetophenone	98-86-2
2-Acetylaminofluorene	53-96-3
4-Aminobiphenyl	92-67-1
Aniline	62-53-3
Anthracene	120-12-7
Aramite	140-57-8
Benz(a)anthracene	56-55-3
Benzenethiol	108-98-5
Benzidine	92-87-5
Benzo(a)pyrene	50-32-8
Benzo(b)fluoranthene	205-99-2
Benzo(ghi)perylene	191-24-2
Benzo(k)fluoranthene	207-08-9
p-Benzoquinone	106-51-4
Bis(2-choroethoxy)ethane	111-91-1
Bis(2-choroethyl)ether	111-44-4
Bis(2-choroisopropyl)ether	39638-32-9
Bis(2-ethylhexyl)phthalate	117-81-7
4-Bromophenyl phenyl ether	101-55-3
Butyl benzyl phthalate	85-68-7
2-sec-Butyl-4,6-dinitrophenol	88-85-7
p-Chloroaniline	106-47-8
Chlorobenzilate	510-15-6
p-Chloro-m-cresol	59-50-7
2-Chloronaphthalene	91-58-7
2-Chlorophenol	95-57-8
3-Chloropropionitrile	54-27-67
Chrysene	218-01-9
ortho-Cresol	95-48-7
para-Cresol	106-44-5
Dibenz(a,h)anthracene	53-70-3
Dibenzo(a,e)pyrene	192-65-4
Dibenzo(a,l)pyrene	189-55-9
m-Dichlorobenzene	541-73-1
o-Dichlorobenzene	95-50-1
p-Dichlorobenzene	106-46-7
3,3'-Dichlorobenzidine	91-94-1
2,4-Dichlorophenol	120-83-2
2,6-Dichlorophenol	87-65-0
Diethyl phthalate	84-66-2
3,3'-Dimethoxybenzidine	119-90-4
p-Dimethylaminoazobenzene	60-11-7
3,3'-Dimethylbenzidine	119-93-7
2,4-Dimethylphenol	105-67-9
Dimethyl phthalate	131-11-3
Di-n-butylphthalate	84-74-2
1,4-Dinitrobenzene	100-25-4
4,6-Dinitro-o-cresol	534-52-1
2,4-Dinitrophenol	51-28-5
2,4-Dinitrotoluene	121-14-2

Parameter	CAS no.
2,6-Dinitrotoluene	606-20-2
Di-n-octyl phthalate	117-84-0
Di-n-propylnitrosamine	621-64-1
Diphenylamine/	122-39-4/
Diphenylnitrosamene	86-30-6
1,2-Diphenylhydrazine	122-66-7
Fluoranthene	206-44-0
Fluorene	86-73-7
Hexachlorobenzene	118-74-1
Hexachlorobutadiene	87-68-3
Hexachlorocyclopentadiene	77-47-4
Hexachloroethane	67-72-1
Hexachlorophene	70-30-4
Hexachloropropene	1888-71-7
Ideno(1,2,3-cd)pyrene	193-39-5
Isosafrole	120-58-1
Methapyrilene	91-80-5
3-Methylcholanthrene	56-49-5
4,4'-Methylenebis(2-chloroaniline)	101-14-4
Naphthalene	91-20-3
1,4-Naphthoquinone	130-15-4
1-Naphthylamine	134-32-7
2-Naphthylamine	91-59-8
p-Nitroaniline	100-01-6
Nitrobenzene	98-95-3
4-Nitrophenol	100-02-7
N-Nitrosodi-n-butylamine	924-16-3
N-Nitrosodiethylamine	55-18-5
N-Nitrosodimethylamine	62-75-9
N-Nitrosomethylethylamine	10595-95-6
N-Nitrosomorpholine	59-89-2
N-Nitrosopiperidine	100-75-4
n-Nitrosopyrrolidine	930-55-2
5-Nitro-o-toluidine	99-55-8
Pentachlorobenzene	608-93-5
Pentachloroethane	76-01-7
Pentachloronitrobenzene	82-68-8
Pentachlorophenol	87-86-5
Phenacetin	62-44-2
Phenanthrene	85-01-8
Phenol	108-95-2
2-Picoline	109-06-8
Pronamide	23950-58-5
Pyrene	129-00-0
Resorcinol	108-46-3
Safrole	94-59-7
1,2,4,5-Tetrachlorobenzene	95-94-3
2,3,4,6-Tetrachlorphenol	58-90-2
1,2,4-Trichlorobenzene	120-82-1
2,4,5-Trichlorophenol	95-95-4
2,4,6-Trichlorophenol	88-06-2
Tris(2,3-dibromopropyl)phosphate	126-72-7

Parameter	CAS no.
METALS	
Antimony	7440-36-0
Arsenic	7440-38-2
Barium	7440-39-3
Beryllium	7440-41-7
Cadmium	7440-43-9
Chromium	7440-47-3
Copper	7440-50-8
Lead	7439-92-1
Mercury	7439-97-6
Nickel	7440-02-0
Selenium	7782-49-2
Silver	7440-22-4
Thallium	7440-28-0
Vanadium	7440-62-2
Zinc	7440-66-6

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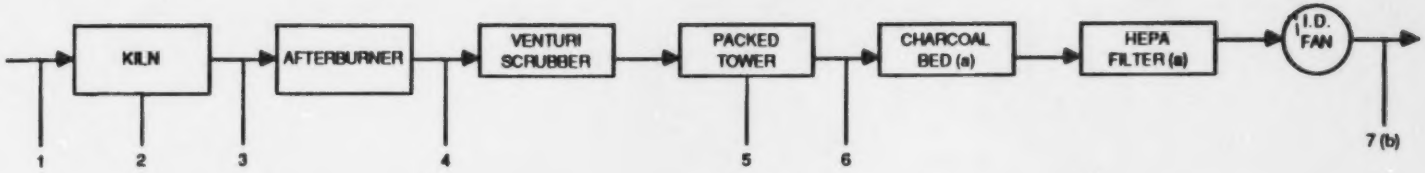

a) The charcoal bed and HEPA filter are not typical for a full scale incinerator. These controls have been added to satisfy Arkansas permit requirements.

b) Sampling at point 7 is required by the CRF's Arkansas permit.

SAMPLING POINT OR MONITORING LOCATION	PARAMETER												
	WASTE FEEDRATE	WASTE FEED	FUEL FEED RATE	AIR FEED RATE	KILN ASH	SCRUBBER BLOWDOWN	CMs O2, CO, CO2	VOLUME FLOW	MM5 (POHC's AND OTHER SEMIVOLATILE ORGANICS)	M5 (PARTICULATE AND HCL)	T	P	RH
1	X	X	X	X									
2					X								
3			X	X							X		
4							X				X		
5						X		X					
6							X	X	X	X	X	X	X
7								X	X	X	X	X	X

CMs: Continuous Monitors
M5: EPA Test Method 5
MM5: EPA Modified Method 5
T: Temperature
P: Pressure
RH: Relative Humidity

Figure 2. Incineration system operating parameters monitored during the test burns.

TABLE 2. DESIGN CHARACTERISTICS OF THE CRF ROTARY KILN SYSTEM

Characteristics of the kiln main chamber:		
Length, outside	2.61 m	(8ft 7in)
Diameter, outside	1.22m	(4ft 0in)
Length, inside	2.13m	(7ft 0in)
Diameter, inside	0.95m	(3ft 1.5in)
Chamber volume	1.74 m3	(61.36 ft3)
Construction	0.63 cm	(0.25 in) thick cold-rolled steel
Refractory	12.7 cm	(5 in) thick high alumina castable refactory, variable depth
Rotation	Clockwise or counterclockwise, 0.2 to 1.5 rpm	
Solids retention	1 hr (at 0.5 rpm)	
Burner - Feed end		
(K024)	John Zink Model RW3F-FL	
(K001, K037)	American Combustion, 1.6 MMBTU/hr	
Primary fuel	Propane	
Solid feed system	Metered twin-auger screw feeder	
Max. temperature	1000 deg C	(1832 deg f)
Characteristics of the afterburner chamber:		
Length, outside	3.05 m	(10 ft 0 in)
Diameter, outside	1.22 m	(4 ft 0 in)
Length, inside	2.74 m	(9 ft 0 in)
Diameter, inside	0.91 m	(3 ft 0 in)
Chamber volume	1.80 m3	(63.6 ft3)
Construction	0.63 cm	(0.25 in) thick cold-rolled steel
Refractory	15.24 cm	(6 in) thick high alumina castable refractory
Gas residence time	1.2 to 2.5 sec (variable)	
Burner		
K024	Iron Fireman Model C-120-G-SMG, 1.8 MMBTU/hr	
K001, K037	American Combustion, 1.2 MMBTU/hr	
Primary fuel	Propane	
Max. temperature	1200 deg C	(2200 deg F)
Air Pollution Control System:		
System capacity		
Inlet gas flow	1.07 m3/min	(3773 acfm) at
	1,200 deg C	(2,200 deg F) and
	101 kPa	(14.7 psia)
Pressure drop		
Venturi scrubber	7.5 kPa	(30 in H2O)
Packed column	1.0 kPa	(4 in H2O)
Liquid flow		
Venturi scrubber	77.2 L/min	(20.4 gpm) at 69 kPa (10 psig)
Packed column	116 L/min	(30.6 gpm) at 69 kPa (10 psig)
Packing	Saddles	
pH control	Feed back control by NaOH solution addition	

Reference: Acurex, 1987

TABLE 3. OPERATING PARAMETERS

RCRA Waste Code	Test date	Waste feed feed rate, lb/h	Kiln temperature (average),°F	Afterburner temperature (average),°F
K024	3/17/87	53	1573-1754 (1707)	1963-2078 (2055)
	3/18/87	108	1713-2026 (1898)	1894-2155 (2025)
	3/19/87	108	1374-1966 (1786)	1921-2091 (2014)
K001	6/26/87	86	1650-2046 (1856)	1840-2033 (1882)
	7/1/87	86	1786-1996 (1854)	1988-2082 (2023)
	7/1/87	86	1774-2002 (1923)	1791-1930 (1843)
K037	9/3/87	110	1778-1870 (1818)	2043-2063 (2051)
	9/9/87	120	1830-1897 (1850)	2046-2055 (2050)

SAMPLE ID	SITE DESCRIPTION	SAMPLE DESCRIPTION
A	Drums	Waste Feed Before Packing
B	Ash Bin	Ash
C	Venturi Scrubber	Scrubber IMakeup
D	Recirculation Tank	Scrubber Blowdown

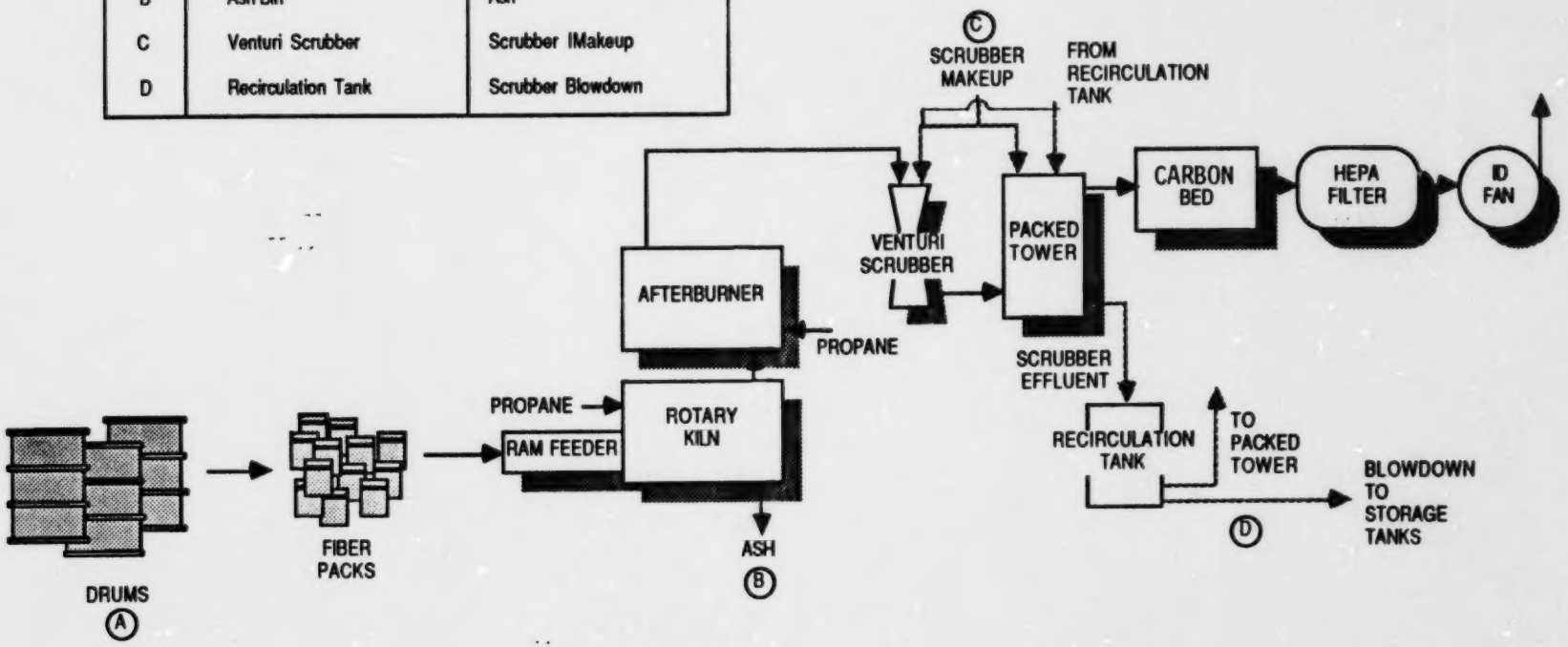

Figure 1. CRF rotary kiln configuration and sampling points.